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(54) SPHEROIDAL GRAPHITE CAST IRON AND PRODUCTION OF SPHEROIDAL GRAPHITE CAST IRON

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a spheroidal graphite cast iron casting having a superfine graphite structure, and in which the generation of a chill structure is prevented.

SOLUTION: As for the method for producing spheroidal graphite cast iron, cast iron contg. 3.10 to 3.90% C, 2.50 to 4.00% Si, 0.45% Mn, ≤0.05% P, ≤0.008% S, ≤0.5% Cu, 0.3% Mo, ≤0.05% Mg, ≤0.1% Bi+Sb+Ti is cast by a metal mold casting method, and a superfine graphite structure is provided in the casting.

LEGAL STATUS

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CLAIMS

[Claim(s)]
[Claim 1] C -- 3.10 - 3.90%, and Si -- 2.50 - 4.00%, and Mn -- 0.45% or less and spheroidal graphite cast iron which contains Mo for Cu 0.5% or less 0.008% or less, contains Bi+Sb+Ti for Mg 0.1% or less 0.05% or less 0.3% or less, and is used [S / 0.05% or less and] for a metal-mold-casting method in P.
[Claim 2] Spheroidal graphite cast iron according to claim 1 characterized by containing rare earth elements 0.1% or less.
[Claim 3] Spheroidal graphite cast iron according to claim 1 characterized by casting having a detailed graphite organization.
[Claim 4] C -- 3.10 - 3.90%, and Si -- 2.50 - 4.00%, and Mn -- a casting method of spheroidal graphite cast iron of containing Mo for Cu 0.5% or less 0.008% or less, containing [S] Bi+Sb+Ti for Mg 0.1% or less 0.05% or less 0.3% or less, casting P by metal-mold-casting method 0.05% or less 0.45% or less, and having made it have a detailed graphite organization in casting.
[Claim 5] Inflow speed into metal mold is carried out in 1.5kg/second or less, a cooling rate is cast in a second in 15 degrees C /or more, and it is the number of nodular graphite grains 1900 pieces/mm 2 A casting method of spheroidal graphite cast iron according to claim 4 characterized by carrying out crystallization above.
[Claim 6] A casting method of spheroidal graphite cast iron according to claim 4 that the minimum thickness is characterized by performing thick different casting which has a value of 10mm or less by 2mm or more using metal mold.
[Claim 7] A casting method of spheroidal graphite cast iron according to claim 4 characterized by preventing generating of a chill organization by the detailed graphite organization which consists of a nodular graphite grain.
[Claim 8] A casting method of spheroidal graphite cast iron according to claim 7 characterized by making it the sum total of Si become 2.50 - 4.00% by performing **** to serve also as one inoculation or more by the time it carries out spheroidizing of the molten metal by spheroidizing agent and carries out teeming to metal mold.
[Claim 9] A casting method of spheroidal graphite cast iron according to claim 8 characterized by **** being 0.2% or more.
[Claim 10] A casting method of spheroidal graphite cast iron according to claim 4 characterized by casting cast by metal-mold-casting method being a piston for internal combustion engines.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] This invention relates to the spheroidal graphite cast iron start [spheroidal graphite cast iron] spheroidal graphite cast iron and its casting method, especially it was made to make the casting produce a detailed graphite organization, and its casting method.
[0002]
[Description of the Prior Art] When a spheroidal-graphite-cast-iron casting is manufactured by the metal-mold-casting method, since the cooling rate is quick, in a Prior art, a chill organization occurs to the field in Mr. about about 10mm Fukashi from the casting surface of the casting which touches metal mold. That is, according to the crystallization mechanism of the nodular graphite crystallized from a molten metal, it is essentially easy to supercool spheroidal graphite cast iron, and moreover, according to the metal-mold-casting method the cooling rate in mold is quick, it will promote supercooling further, and chill-ization will be promoted by this.
[0003] For this reason, a casting is heated at the temperature around 900 degrees C for several hours, and if a chill organization is not decomposed, the casting which can be equal to use is not obtained. Therefore, in the casting cast by the metal-mold-casting method, such heat treatment is indispensable from before, and the casting is manufactured by performing a heat treatment process after a casting.
[0004]
[Problem(s) to be Solved by the Invention] What spheroidal graphite cast iron essentially tends to supercool is as a result of [inevitable] the generation process of nodular graphite. That is, since a graphite is surrounded by the austenite from an eutectic reaction start point, a graphite cannot be grown up if a carbon atom is not supplied through an austenite phase. And big energy is needed for such growth. This will absorb heat from the perimeter in the case of growth, and a supercooling phenomenon produces it by this. Such a phenomenon is the point that the flaky graphite which is always in contact with the molten metal is large, and the tips of a graphite differ.
[0005] Supposing the molten metal of the spheroidal graphite cast iron by which spheroidizing was carried out has the nucleus of enough graphites to generate a supercooling phenomenon By seldom adhering to growing up a spherical organization, but taking a means to make the nucleus of a graphite generate rather still more positively, without extinguishing the nucleus of this graphite from this While the metal-mold-casting method enabled it to obtain sufficient detailed graphite organization, the invention-in-this-application person etc. found out that it became possible to aim at prevention of generating of a chill at this time.
[0006] this invention is made based on such knowledge, and it aims at offering the casting method of the spheroidal graphite cast iron which it moreover ****, comes out especially by the metal-mold-casting method, and can manufacture a spheroidal-graphite-cast-iron casting, and spheroidal graphite cast iron.
[0007]
[Means for Solving the Problem] It concerns Mn to spheroidal graphite cast iron which contains Mo for Cu 0.5% or less 0.008% or less, contains Bi+Sb+Ti for Mg 0.1% or less 0.05% or less 0.3% or less, and

is used [S / 0.05% or less and] for a metal-mold-casting method in P 0.45% or less 3.10 to 3.90% in C, this invention concerning 2.50 - 4.00% in Si.
[0008] Rare earth elements may be contained 0.1% or less here. Moreover, casting may have a detailed graphite organization. Furthermore, Sn of a minute amount may be added if needed.
[0009] It concerns Mn to a casting method of spheroidal graphite cast iron contains 0.5% or less and Mo for 0.008% or less and Cu, contains [0.45% or less and P / 0.05% or less and S] 0.05% or less and Bi+Sb+Ti for 0.3% or less and Mg 0.1% or less, casts by metal-mold-casting method, and it was made to have a detailed graphite organization in casting in C, invention about a casting method concerning 2.50 - 4.00% in 3.10 - 3.90%, and Si.
[0010] Inflow speed into metal mold is carried out in 1.5kg/second or less, a cooling rate is cast in a second in 15 degrees C /or more, and it is the number of nodular graphite grains 1900 pieces/mm 2 Crystallization may be carried out above. Moreover, thick different casting whose minimum thickness has a value of 10mm or less by 2mm or more using metal mold may be performed. Moreover, generating of a chill organization may be prevented by the detailed graphite organization which consists of a nodular graphite grain.
[0011] You may make it the sum total of Si become 2.50 - 4.00% by performing **** to serve also as one inoculation or more, by the time it carries out spheroidizing of the molten metal by spheroidizing agent and carries out teeming to metal mold in invention about an above-mentioned casting method especially. Moreover, **** may be 0.2% or more. Moreover, casting cast by this casting method may be a piston for internal combustion engines.
[0012]
[Embodiment of the Invention] As the gestalt of desirable operation of this invention is shown in a table 1, C 3.10 - 3.90%, For Mn P 0.45% or less 1.0 to 2.0% 0.05% or less, [Si] For Cu Mo 0.5% or less 0.008% or less 0.3% or less, [S] The temperature up of the former molten bath of the spheroidal graphite cast iron which contains Bi+Sb+Ti for Mg 0.1% or less 0.05% or less is carried out to about 1500 degrees C. After measuring the predetermined amount of molten metals, until just before performing spheroidizing by 2% or less of spheroidizing agent and carrying out teeming of the molten metal to metal mold further, 0.2% or more of **** is carried out to serve also as one inoculation or more in between. It is made for the content of Si to become within the limits which is 2.50 - 4.00% by such ****.
[A table 1]

表 1 目標化学成分範囲

Wt%	T. C	S I	Mn	P	S	Cu	Mo	Mg	(ΣT)	Fe
目標範囲	3.10～3.90	2.5 ～4.0	<0.45	<0.05	<0.008	<0.5	<0.3	<0.05	(<0.1)	残
最適値 (Wt%)	3.8	3.0	<0.45	<0.05	<0.008	<0.5	<0.3	<0.05	(<0.1)	残

ΣT = Bi + Sb + Ti　　( ) は参考値

A final presentation is illustrated as an optimum value shown in the lower column of a table 1. Here, it is [C] spheroidal graphite cast iron of the presentation which contains Cu for Mo 0.3% or less 0.008% or less, contains [P / S] Bi+Sb+Ti for Mg 0.1% or less 0.05% or less 0.5% or less 0.05% or less, and contains Sn of a minute amount, and 0.1% or less of rare earth elements if needed further 0.45% or less about Mn 3.0% in Si 3.8%.
[0013] At this time, the casting conditions of metal mold, i.e., the cooling conditions of a molten metal,

adjust 15 degrees C/[a second and] or more and inflow speed so that a second may come in 1.5kg /or less. The cast casting completes coagulation, is made to perform drawing of the casting from metal mold around 900 degrees C which reaches the reinforcement which fully deals with it and is made, and carries out atmospheric-air radiationnal cooling next. the casting of the microstructure which *** and comes out by this and does not have a chill organization and which overly has a detailed graphite organization is obtained.

[0014] drawing 1 is such -- a photograph overly shows the microstructure of a detailed graphite organization. Drawing 2 shown for contrast shows the conventional chill organization.

[0015] In the thick different casting whose cast minimum thickness is 2-10mm, if Si addition which served as inoculation is changed without changing the content of Si in the molten metal before spheroidizing, and the addition of a spheroidizing agent and the content of Si as the whole is made to increase, the number of grains of a graphite will come to be shown in drawing 3 , and the number of grains will increase sharply in connection with the content of Si as the whole increasing. By making the content of Si into 2.5% with the thick different casting whose minimum thickness is 2-10mm, the number of graphites is 2 about 1900 pieces/mm. It becomes. This value is mostly equivalent to the limit of chill generating. On the other hand, if the content of Si is made about 4.0% or more, fluidity will deteriorate. Therefore, it is desirable to make a maximum into 3.90% or less.

[0016]

[Example] Next, one example which applied this invention to casting of the piston of the high performance which overly has a detailed nodular graphite organization is explained below.

[0017] the thickness in within the limits whose minimum thickness is 2-10mm -- by the metal-mold-casting method, inflow speed cast the spheroidal-graphite-cast-iron piston whose different diameter is 150mm in 1.5kg/[in a second] or less, and cast the cooling rate in 15 degrees C/[in a second] or more.

[A table 2]

表 2 実施例（φ150金型鋳造ピストン）

	T. C	Si	Mn	P	S	Cu	Mg	(ΣT)	Fe
サンプルA	3.72	2.44	0.44	0.003	0.007	0.48	0.032	(<0.1)	残
サンプルB	(3.32)	2.57	0.43	0.003	0.006	0.48	0.029	(<0.1)	残
サンプルC	(3.35)	2.89	0.43	0.002	0.006	0.47	0.038	(<0.1)	残
サンプルD	(3.15)	3.24	0.44	0.004	0.007	0.47	0.039	(<0.1)	残
サンプルE	(3.23)	3.28	0.43	0.003	0.007	0.47	0.037	(<0.1)	残

（ ）は参考値 サンプルAは比較例 ΣT－Bi＋Sb＋Ti

The presentation of the casting at this time is shown in a table 2. It cast about the casting of five levels shown here, respectively, and the sample mark was set to A, B, C, D, and E at the order of casting. In addition, the sample A of a table 2 is the component value of the conventional presentation. That is, Si is ****(ed) 0.2% by the inoculation which Si in a former molten bath is 1.24%, and 1.0%Si is added by spheroidizing, and performs Sample A to spheroidizing and coincidence, and, finally cast Si content has become 2.44%.

[0018] On the other hand, Samples B, C, D, and E do not change the content, the amount of spheroidizing, and the amount of inoculation of Si of Sample A, but change Si content by **** which served as the inoculation in front of casting to 2.44% of Si of Sample A. [of a former molten bath]

[0019] The minimum thick section of a piston is cut after casting, and the result of having questioned the microstructure is shown by the photograph in drawing 1 . On the other hand, the organization of Sample A is shown in drawing 2 . when Si is less than 2.5% so that clearly from the photograph of drawing 2 , by a chill occurring, also although kicked, it ** *, when [with many graphite grains] Si is 2.5% or more to this, and it comes out, and the chill has not occurred. moreover, the number of graphite grains -- about 1900 -- piece/mm2 it is -- things are understood. The number of graphite grains is 2 1900 pieces/mm. If it is the above chill generating prevention field, heat treatment which was required for the temper is not only unnecessary, but fatigue strength improves as a mechanical property and it can expect improvement in improvement in thermal conductivity, wear-resistant improvement, and cutting ability as a physical property.

[0020] By improvement of these properties, the piston made of spheroidal graphite cast iron by the metal-mold-casting method of this example can be contributed to the high increase in power expected from the internal combustion engine of heavy load high rotation, the reduction in the noise, low-fuel-consumption-izing, and the cure against exhaust gas, and turns into a high performance piston in this semantics. That is, offer of a high performance piston is attained by using the method of this example.

[0021]

[Effect of the Invention] It concerns Mn to the spheroidal graphite cast iron contains 0.5% or less and Mo for 0.008% or less and Cu, contains [0.45% or less and P / 0.05% or less and S] 0.05% or less and Bi+Sb+Ti for 0.3% or less and Mg 0.1% or less, casts by the metal-mold-casting method, and it was made overly to have a detailed graphite organization in the casting, and the casting method in C as mentioned above, this invention concerning 2.50 - 4.00% in 3.10 - 3.90%, and Si.

[0022] Therefore, according to such cast iron and the casting method, generating of a chill organization is prevented and it becomes possible to offer the casting which has a detailed organization.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the photograph in which the microstructure of the casting by the cast iron concerning the mode of 1 operation of this invention is shown.
[Drawing 2] It is the photograph in which the microstructure of the conventional spheroidal-graphite-cast-iron casting is shown.
[Drawing 3] It is the graph which shows change of the number of graphite grains to the content of Si.

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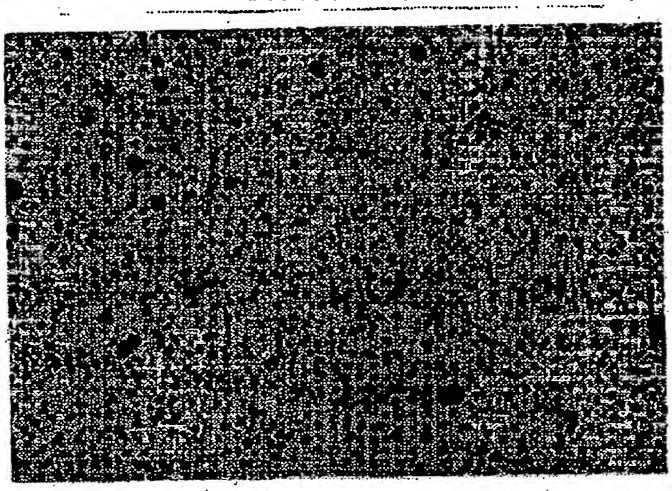
DRAWINGS

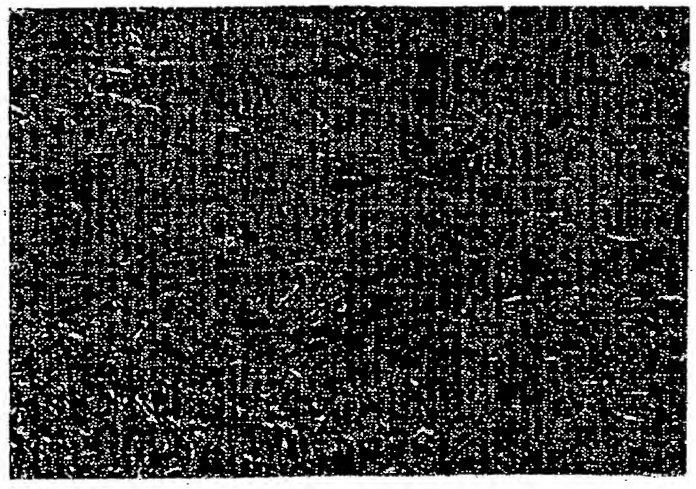
[Drawing 1]

図面代用写真



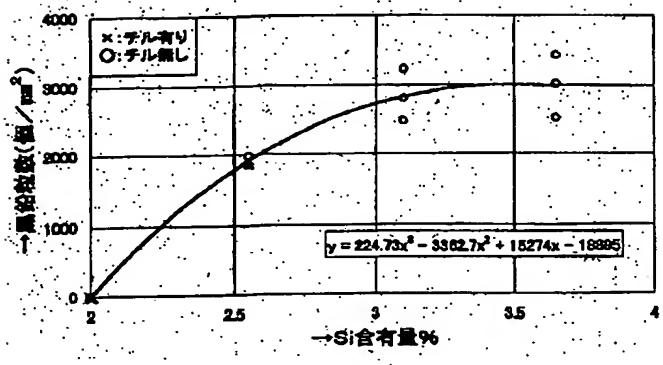
[Drawing 2]

図面代用写真



[Drawing 3]

Si含有量と黒鉛粒数との関係



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